

MEMORANDUM

TO: Amy Hambrick, U.S. EPA, Sector Policies and Programs Division/Natural Resources and Commerce Group

FROM: Amber Allen and Danny Greene; Eastern Research Group, Inc.

DATE: June 2010

SUBJECT: Secondary Impacts of Control Options for the Sewage Sludge Incineration Source Category

1.0 INTRODUCTION

This memorandum presents the secondary impacts associated with control devices used to comply with the proposed standards for existing and new sewage sludge incineration (SSI) units. Secondary impacts result from the consumption of fuel, water, and electricity and generation of solid wastes by control devices.

Section 2.0 presents the background for the proposed standards. Section 3.0 presents the secondary impact estimates associated with control devices necessary for two scenarios: (1) all SSI units comply with proposed standards, and (2) only large entities comply with the proposed standards and small entities divert their waste to landfills. This memorandum focuses only on secondary impacts associated with control devices. Additional air impacts resulting from small entities choosing to landfill are discussed in a separate memorandum.¹ Section 4.0 summarizes the estimated secondary impacts that would result from the compliance of new units expected to come online in the next five years. Section 5.0 summarizes the emissions resulting from increased fuel and electricity requirements for the control options.

2.0 BACKGROUND

The U.S. Environmental Protection Agency (EPA), under section 129 of the Clean Air Act (CAA), is required to regulate emissions of 9 pollutants and opacity from existing sewage sludge incineration (SSI) units. The 9 pollutants are: hydrogen chloride (HCl), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), particulate matter (PM), dioxins/furans (CDD/CDF), nitrogen oxides (NO_x), and sulfur dioxide (SO₂). The CAA requires EPA to determine the maximum achievable control technology (MACT) for each category or subcategory of sources. The SSI source category comprises two subcategories: multiple hearth incineration units (MH) and fluidized bed incineration units (FB). To determine the MACT for each subcategory, EPA must first determine the minimum stringency “floor” requirements. Development of the MACT floors for SSI units is described in a separate memorandum.² An analysis of beyond-the-floor options was also conducted, in which three different control options were evaluated.

- Option 1 is the MACT floor level of control for the two subcategories developed for existing SSI units, MH units and FB units.
- Option 2 is the same as Option 1, with the addition of activated carbon injection (ACI) for additional Hg and CDD/CDF emissions reduction from MH units.
- Option 3 is the same as Option 2, with the addition of an afterburner on all MH units for additional control of CO.

3.0 SECONDARY IMPACT ESTIMATES FOR EXISTING UNITS

To comply with the control options, facilities may need to install the following types of control devices on SSI units:

- Fabric filters (FF) to reduce Cd, Pb, and PM emissions,
- Packed-bed scrubbers (PBS) to reduce HCl and SO₂ emissions,
- ACI systems to reduce CDD/CDF and Hg emissions, and
- Afterburners (AB) to reduce CO and organic compound emissions.

Electricity is required to operate the pumps and fans associated with FF and PBS systems. Also, water and subsequent wastewater disposal are required to operate PBS systems. Fabric filter and ACI systems require a method to dispose of the dust produced from the systems. Additionally, ACI requires the use of activated carbon. Supplemental fuel (i.e., natural gas) is required to operate afterburners for MH SSI units.

Table 3-1 shows, for each of the control options, the estimated secondary impacts for the FB and MH subcategories for the case where all entities comply with the control option. Table 3-2 shows, for each of the control options, the estimated secondary impacts for the case where small entities landfill and large entities comply.

The algorithms used in the cost analysis provide annual cost estimates for electricity, water, carbon requirements, and supplemental fuel as itemized components of the annual costs for the control device.¹ These cost elements for the control devices anticipated to be installed to comply with the proposed standards were then summed up to provide an estimate of the overall costs of electricity, water, activated carbon, and supplemental fuel. To estimate the secondary impact components (e.g., electricity, water, dust), the itemized annual cost of each component was divided by the unit price of the component used by the algorithm.

Table 3-1. Secondary Impacts for Control Options: All Units Comply

Control Option	Subcategory	Controls Required for Compliance	Electricity Required (MW-hr/yr)	Water Required (gal/yr)	Activated Carbon Required (ton/yr)	Dust Produced (ton/yr)	Supplemental Fuel (ft ³ natural gas/yr)
Option 1	FB units	FF, PB, ACI	13,750	31,983,667	1,711	1,762	-
	MH units	FF, PB, ACI	20,088	314,409,712	35	347	-
	Total	FF, PB, ACI	33,839	346,393,379	1745	2109	-
Option 2	FB	FF, PB, ACI	13,750	31,983,667	1,711	1,762	-
	MH	FF, PB, ACI	20,088	314,409,712	9,725	10,037	-
	Total	FF, PB, ACI	33,839	346,393,379	11,436	11,799	-
Option 3	FB	FF, PB, ACI	13,750	31,983,667	1,711	1,762	-
	MH	FF, PB, ACI, AB	20,088	314,409,712	9,725	10,037	1,686,090,925
	Total	FF, PB, ACI, AB	33,839	346,393,379	11,436	11,799	1,686,090,925

Table 3-2. Secondary Impacts for Control Options: Small Entities Landfill

Control Option	Subcategory	Controls Required for Compliance	Electricity Required (MW-hr/yr)	Water Required (gal/yr)	Activated Carbon Required (ton/yr)	Dust Produced (ton/yr)	Supplemental Fuel (ft ³ natural gas/yr)
Option 1	FB units	FF, PB, ACI	10,662	21,432,013	1,381	1,421	-
	MH units	FF, PB, ACI	18,548	297,979,345	35	319	-
	Total	FF, PB, ACI	29210	319,411,358	1,416	1,740	-
Option 2	FB	FF, PB, ACI	10,662	21,432,013	1,381	1,421	-
	MH	FF, PB, ACI	18,548	297,979,345	8,674	8,958	-
	Total	FF, PB, ACI	29210	319,411,358	10,055	10,379	-
Option 3	FB	FF, PB, ACI	10,662	21,432,013	1,381	1,421	-
	MH	FF, PB, ACI, AB	18,548	297,979,345	8,674	8,958	1,550,033,242
	Total	FF, PB, ACI, AB	29210	319,411,358	10,055	10,379	1,550,033,242

4.0 SECONDARY IMPACT ESTIMATES FOR NEW UNITS

As discussed in the new source analysis memorandum, EPA expects that two new FB units would come online in the next five years⁴. Estimations of the secondary impacts resulting from the pollution controls implemented for these units were calculated using the same methodology described for existing units in Section 3.0.

Table 4-1 shows the estimated values for secondary impacts for the two new FB units.

Table 4-1. Secondary Impacts: New Units

Subcategory	Controls Required for Compliance	Electricity Required (MW-hr/yr)	Water Required (gal/yr)	Activated Carbon Required (ton/yr)	Dust Produced (ton/yr)	Supplemental Fuel (mmcf natural gas/yr)
New Units	FF, PBS, ACI, AB	1,348	18,267,411	97	100	25

5.0 SECONDARY AIR POLLUTANT IMPACTS

Emission factors from EPA's Egrid⁵ database were used to calculate emissions resulting from the electricity required for additional control devices, and emission factors from EPA's AP-42 emission factor document⁶ were used to calculate emissions resulting from the combustion of additional fuel for afterburners. Increased electrical use from the control options will require additional fuel to be burned in power plants, resulting in emissions of CO₂ and criteria pollutants, such as SO₂, NO_x, and CO. Emissions of these pollutants (caused by increase in electricity) were estimated using EPA's Egrid database.⁵ The Egrid database summarizes emissions of criteria pollutants on a per electrical usage basis (lb emitted per MW-hr), on a national average or state average basis. For this analysis the national average was used. Option 3 also requires afterburners to be applied to all MH units, resulting in supplemental fuel requirements, such as natural gas, to run the afterburner. The afterburner algorithm indicates the amount of fuel needed by each unit. To estimate emissions from combustion of natural gas, emission factors from EPA's AP-42 emission factor document were used.⁶ Tables 5-1 summarizes the resulting emissions of CO₂, CO, NO_x, and SO₂ from combustion of natural gas supplemental fuel and increase electricity usage for the three control options analyzed for existing sources. Table 5-2 shows the results for new sources, and table 5-3 shows results for combined existing and new sources. Table 5-4 shows the Egrid and AP-42 emission factors used for the calculations.

Table 5-1. Secondary Air Pollutant Impacts: Existing Units

All Units Comply												
Option	Electricity Requirements and Emissions (tons/yr)*				Supplemental Fuel Requirements and Emissions (tons/yr)*				Total Secondary Emissions (tons/yr)			
	MWh per yr	CO ₂ Emitted	NO _x Emitted	SO ₂ Emitted	ft ³ Natural Gas per yr	CO ₂ Emitted	CO Emitted	NO _x Emitted	CO ₂ Emitted	CO Emitted	NO _x Emitted	SO ₂ Emitted
1	33,839	22,500	32.8	89.0	-	-	-	-	22,500	-	32.8	89.0
2	33,839	22,500	32.8	89.0	-	-	-	-	22,500	-	32.8	89.0
3	33,839	22,500	32.8	89.0	1,686,000,000	101,200	70.8	84.3	123,700	70.8	117.1	89.0
Small Units Landfill												
Option	Electricity Requirements and Emissions (tons/yr)*				Supplemental Fuel Requirements and Emissions (tons/yr)*				Total Secondary Emissions (tons/yr)			
	MWh per yr	CO ₂ Emitted	NO _x Emitted	SO ₂ Emitted	ft ³ Natural Gas per yr	CO ₂ Emitted	CO Emitted	NO _x Emitted	CO ₂ Emitted	CO Emitted	NO _x Emitted	SO ₂ Emitted
1	29,210	19,400	28.3	76.8	-	-	-	-	19,400	-	28.3	76.8
2	29,210	19,400	28.3	76.8	-	-	-	-	19,400	-	28.3	76.8
3	29,210	19,400	28.3	76.8	1,550,000,000	93,000	65.1	77.5	112,400	65.1	105.8	76.8

*Emissions estimated based on emission factors listed in Table 5-4.

Table 5-2. Secondary Air Pollutant Impacts: New Units

Electricity Requirements and Emissions (tons/yr)*				Supplemental Fuel Requirements and Emissions (tons/yr)*				Total Secondary Emissions (tons/yr)			
MWh per yr	CO ₂ Emitted	NO _x Emitted	SO ₂ Emitted	ft ³ Natural Gas per yr	CO ₂ Emitted	CO Emitted	NO _x Emitted	CO ₂ Emitted	CO Emitted	NO _x Emitted	SO ₂ Emitted
1,348	896	1.31	3.54	24,514,485	1,470	1.03	1.23	2,370	1.03	2.53	3.54

*Emissions estimated based on emission factors listed in Table 5-4.

Table 5-3. Secondary Air Pollutant Impacts: Combined Existing and New Units

Total Secondary Emissions (tons/yr)								
Option	All Units Comply				Small Units Landfill			
	CO ₂ Emitted	CO Emitted	NO _x Emitted	SO ₂ Emitted	CO ₂ Emitted	CO Emitted	NO _x Emitted	SO ₂ Emitted
1	24,900	1.03	35.3	92.5	21,782	1.03	30.8	80.3
2	24,900	1.03	35.3	92.5	21,782	1.03	30.8	80.3
3	126,000	71.8	119.6	92.5	114,784	66.1	108.3	80.3

Table 5-4. Emission Factors

Pollutant	Electricity ^a	Natural Gas ^b		
	(lb/MWh)	(lb/10 ⁶ scf)	(lb/ft ³)	(ton/ft ³)
CO ₂	1,329	120,000	0.12	0.00006
CO	-	84	8E-05	4.2E-08
NO _x	1.9366	100	0.0001	5E-08
SO ₂	5.2589	-	-	-

a. National emission factors from Egrid³ for EGUs.

b. Natural gas emission factors from AP-42.⁶

REFERENCES

1. Cost and Emission Reduction of the MACT Floor Level of Control. Memorandum from Amber Allen and Roy Oommen, Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. June 2010.
2. MACT Floor Analysis for the Sewage Sludge Incinerator Source Category. Memorandum from Roy Oommen, Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. June 2010.
3. Analysis of Beyond the Maximum Achievable Control Technology (MACT) Floor Controls for Existing SSI Units. Memorandum from Roy Oommen, Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. August 2010.
4. Estimation of Impacts for New Units Constructed Within Five Years After Promulgation of the SSI NSPS. Memorandum from Roy Oommen, Eastern Research Group, Inc. to Amy Hambrick, U.S. Environmental Protection Agency. June 2010.
5. EPA eGRID database eGRID2007 Version 1.1. Year 2005 summary tables located at www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_SummaryTables.pdf
6. U.S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors (AP-42), Fifth Edition, Volume 1: Stationary and Point Sources, Chapter 1: External Combustion Sources.